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**開発途上国の農業機械化促進に有効な  
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## Research paper

# Effective Methodologies for Knowledge and Technology Transfer with Regard to the Promotion of Agricultural Mechanization in Developing Countries<sup>\*1</sup>

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<sup>\*1</sup> Partly Presented at SASJ Annual Meetings in 2014 and 2015

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## Abstract

JICA (Japan International Cooperation Agency) Tsukuba International Center has implemented a continuous human resource development scheme of technical cooperation through Farm mechanization training (FMT) courses since 1964. This has formed part of an on-going ODA commitment and is subject to the administrative officials and agricultural engineers from representative for developing countries.

This study was undertaken with the aim of supporting future development of the FMT courses. The surveys were conducted for participants after their return to verify the impact of the FMT courses on agricultural mechanization in developing countries. After years of study, it was confirmed that the participants transferred their knowledge and technology, acquired during FMT courses. To elucidate the mechanisms by which knowledge and technology transfers activities in developing countries occurred by participants, the authors considered the information via four transfer types based on farm mechanization promotion levels in developing countries. Moreover, it was found that one important factor generated was the development of an informal network (FMK-net: Farm mechanization knowledge network) between participants and experts in agricultural machinery through transfer activities. The creation of a network between FMK-net and the enterprises, together with FMT, was found to be one of efficient model for overseas expansion, especially for Japanese small and medium sized enterprises. This finding was based on the results of the visiting surveys and actual networking activities between FMK-net and the Enterprises. It is argued that these models can be used to help develop new types of knowledge and technology transfers in agricultural mechanization for developing countries.

**Keywords:** Farm mechanization training (FMT), Knowledge and technology transfer, Farm mechanization knowledge network (FMK-net), Business for overseas expansion

## 1. Introduction

Japan's Official Development Assistance (ODA) began in 1954 after the Japanese government became a signatory to the Colombo Plan. A "Rice production mechanization" course, held in 1964, was the first training course in the field of farm mechanization undertaken by the Overseas Technical Cooperation Agency (OTCA), the predecessor of JICA. After the Tsukuba International Agricultural Training Center (JICA Tsukuba) was opened in Tsukuba Science city in 1982, the Farm mechanization training (hereinafter referred to as FMT) courses were transferred to the JICA Tsukuba site.

Administrators, researchers, and engineers from governmental institutes in developing countries attend the FMT courses for the purpose of human resource development towards promoting farm mechanization in their countries. At the end of March 2013, the total number of FMT courses undertaken

since the first course reached 757 drawing participants from 76 countries. (3.5 % of JICA Tsukuba total 21 439 participants)

The duration of a FMT is 9 months which is a relatively long period when compared with JICA training courses in other fields. (JICA Tsukuba implemented 30 group-training courses in the field of rural development. About 16.6 % of the courses was long period course.) Participants are encouraged to learn about agricultural mechanization and examine case studies of practices in Japan thereby gaining a basic knowledge and practical understanding of the technology necessary to produce agricultural machinery. Participants are expected to develop prototype machines that would fulfill the requirements of their home countries for small-scale farmers. Field trips to national institutes and agricultural machinery/facilities manufacturers (hereinafter referred to as Enterprises) are also arranged as part of the courses.

The contents of the training courses have been revised

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periodically in response to changing needs. An important component of the training is the high level of support participants received from two FMT instructors throughout the duration of the course. Assistance is on offer for the entire process of producing proto-types: planning, design, blue prints, trialing, function testing, and report writing. The two FMT instructors provide detailed attention, from the participants' action plans through to execution, with additional follow up after they return to their home countries.

In spite of the fact that substantial training courses have been carried out for more than 50 years, there has been little research undertaken as to how effectively participants have absorbed the knowledge that they have learnt in Japan and by what methodologies they may have later applied it in their home countries to promote farm mechanization.

Japan's ODA budget was reduced after the collapse of the bubble economy and the subsequent recession in the 1990's; with the budget allocated in 2012 being only half of that for 1997. The authors consider that it is time to reconsider the recent emphasis of Japanese ODA which has been focused on developing the business environment, infrastructure, and law enforcement, towards the aim of further assisting Japanese companies to extend their overseas business from 2013. Therefore, it would be advisable to reassess the present day situation, consider difficulties with the existing FMT and possible modifications to the courses provided for the small and medium enterprises (hereinafter referred to as SMEs).

In this study, the authors inspected and clarified the actions taken by participants to advance farm mechanization in their home countries after having attended FMT. This paper examines the post-training effect in accordance with the amount of time elapsed after the courses, together with the impact of the knowledge and technology transfers (hereinafter referred to as the transfer). Furthermore, the prolonged recession, rapid depreciation of the yen and aging agricultural workforce has raised challenges for Japanese SMEs. There is a pressing need for such enterprises to engage in targeted overseas expansion. In such a situation, the hypothesis is that FMT participants, as it presently exists in the world, are an effective instrument for Japanese SMEs to gain: personnel contacts, information about developing countries' needs, and identification of potential partners, at an early stage of overseas operations, such as, for the adaption and market testing of products for local use.

## 2. Methodology

In this study, the following surveys and actions were performed to ascertain an effective methodology for the transfer of knowledge regarding in-the-field farm mechanization for developing countries. Moreover, it was proposed that the following method be adopted to assess FMT for practical use in assisting businesses with overseas expansion.

The following seven kinds of surveys and actions were undertaken:

1) Examination of past final reports on FMT written by instructors together with Action plans (hereinafter referred to as AP), and final outputs produced by participants from January 2012 to May 2013.

2) Distribution of questionnaires regarding to the progress of AP and the details of activities to 39 participants (10 participants in 2009, 7 participants in 2010, 6 participants in 2011, 9 participants in 2012, 7 participants in 2013) on the "Development farm machinery for small-scale farmers" course. The first survey was conducted in November 2012. The second survey was conducted in June 2013 and the last survey was conducted in July 2014.

3) Life history survey method<sup>1</sup> undertaken with 19 participants continuously who completed the questionnaire, see above item 2) from July 2013 to September 2014.

-Survey on the knowledge and technology transfer activity and the budget allocation after completion of the training course.

4) Identification and focusing on participants who exhibited noticeable results in the life history survey, item 3), and undertaking field surveys at Bangkok, Thailand, and Phnom Penh, Cambodia, to confirm the information provided. The first survey was conducted in November 2012. The second survey was conducted in December 2013.

- Survey on the acquisition and use of knowledge and technology after completion of the training course. Participants, participants' supervisors and other involved persons were questioned.

- Survey of fieldwork for agricultural mechanization in the respective countries and a fact-finding survey on the overseas expansion of Japanese Enterprises.

5) Distribution of questionnaires and visiting surveys to eight companies who had taken part in FMT courses and had started or wished to start overseas operations from November 2012 to October 2014.

- In the interviews, the Enterprises were asked to give the reasons for: their involvement with FMT, their desire to expand operations abroad, and on perceived potential obstacles to commencing overseas activities.

6) Mediation to help construct a network between two Japanese enterprises and participants together with FMT instructors using the FMT from March 2013 to May 2015.

- As an exercise to facilitate the formation of connections between the participants and the Enterprises, whitening machines from two SMEs were chosen for performance testing.

- The companies' representatives in charge of product devel-

<sup>1</sup> Sociological research method which obtains an overall picture of a particular individual by focusing on and considering the working life story of a particular person through interviews

opment explained the function and history behind the machines' development allowing the participants to gain a full understanding of the machines' advantages.

- This was followed by visits to the companies' factories where the participants were able to observe the manufacturing processes for the machinery.

7) Examination of the effectiveness of networking between Japanese enterprises and participants to promote overseas operations.

- The Authors and FMT instructors monitored how participants transferred knowledge and technology after they returned to their countries. Advice was offered via e-mail and social network tools. ; Facebook and LinkedIn., thereby ensuring that participants could join the existing FMK-net or, alternatively, effectively create a new network.
- An FMT instructor also planned and coordinated a project to expand and strengthen FMK-net. The instructor accompanied the Enterprises on an overseas research trip, providing advisory and translation services, while also offering technical assistance to participants and their organizations.

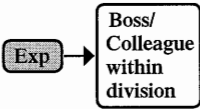
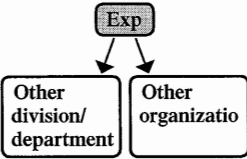
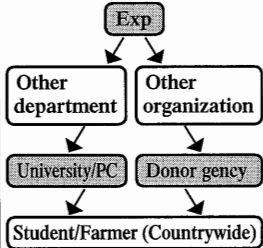
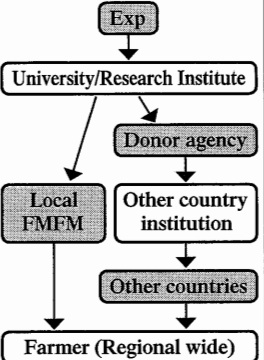
### 3. Results and Discussion

#### 3.1 Case studies examining forms of transfer

It was confirmed that the participants transferred their knowledge, learnt through the FMT courses in Japan, on return to their home countries using the types of method, shown in Figure 1.

##### 3.1.1 Horizontal Transfer (Type 1)

In Horizontal Transfer, the acquired knowledge of participants is transferred to their supervisors and/or colleagues through reporting within their own group. As the training courses form part of ODA; the participants are considered to be representatives of their countries and are required to submit written reports of their training courses and present their findings to their colleagues within one month after returning from Japan. Through this reporting system, the knowledge, technology, and APs made by participants in Japan are further disseminated. However, with this system, the impact of spreading outputs from the FMT for the promotion of farm mechanization in their home countries is at a minimal level.

Type of transfer	Horizontal (Type1)	Vertical (Type2)	Tree Style(Type 3)	Complex Style (Type 4)
Image of transfer/spread				
Countries of production	Almost all of the countries	Cambodia, Ghana, Nigeria, Pakistan	Rwanda, Tajikistan Bangladesh, Bhutan	Indonesia, Thailand (Madagascar, Cambodia)
Level of transfer	Within Organization	Beyond Organization	Country wide	Regional wide
Characteristic of the contents of transfer	Information sharing/report on general matter (Japan, Training, etc.)	Knowledge transfer instead of the technology transfer gained through Farm mechanization training	Promoting knowledge and technology transfer, Exp will try to allocate the budget to implement the project. Creating network among the person officially in charge of agricultural mechanization in respective country	Having great impact on the agricultural machinery market, or contributing to promote agricultural mechanization to other countries
Impact of the farm mechanization	Quite low	Limited impact	High	Extremely high

Abbr) Exp: Ex-participant for FMT courses, PC: Private company, FMFM: Farm machinery /facility manufacturer

→: The transfer process

Fig. 1 Types of transfer in developing countries

### 3.1.2 Vertical Transfer (Type 2)

With Vertical Transfer, the transfer is performed through seminars or workshops with various sections from within, or from outside, the participants' organizations. After having obtained permission from their supervisors, some participants undertake continuous implementation of their APs during their daily work and all Transfers should take place within 6 months of the participants return home. A small sum is allocated to the participant's supervisor from within the home country organization's budget to cover any associated costs. Vertical Transfer is considered to be more effective in comparison with Horizontal Transfer (Type 1), as the learnt knowledge can be spread to people beyond the participant's organization. In this situation, the impact of the Transfer of farm mechanization promoted by the participant is often limited by budgetary considerations. A case study from Cambodia is used as an example;

Cambodia is classified as the Least developed country by the UNDP. Cambodia's National agricultural growth strategy for 2015 is to obtain rice production of 4 million tons/year and to increase rice exports to 1 million tons. Ten technical staff from Cambodia have attended FMT courses in the past. Half of these participants belong to the DAEng (Department Agricultural Engineering, Ministry of Agriculture). DAEng's objective is to develop and extend agricultural machinery products to rural areas. Approximately, 20 % of technical staff from DAEng has attended FMT courses; furthermore, the Director of DAEng has also attended a JICA Training course. There have been cases where participants have applied knowledge and technology learnt in Japan towards improving prototypes within the participant' organization and by developing new types of Seeder.

Similar kinds of Vertical Transfer have also been reported from Ghana, Nigeria, and Pakistan.

### 3.1.3 Tree Style Transfer (Type 3)

In Tree Style Transfers, the participant's organization involves other organizations that are not directly related to the agricultural engineering field but concerned with budget allocation or involved in the implementation of a specific project. With a Tree Style Transfer, it is necessary to allocate a budget and to identify suitable human resources within the related organization. Normally, it will take between one to three years to implement a project after the participant has returned to their home country. Nonetheless, Tree Style Transfers appear to impart a positive effect towards implementation of agricultural mechanization within the participants' home countries. The following case study from Rwanda is used as an example;

The Republic of Rwanda is categorized by the UNDP as a Least developed country and more than 90 % of its labor population works in the agricultural sector. The Strategic plan for agriculture in Rwanda foresees a shift towards market-

oriented agro-business from the current self-sufficiency agriculture through increasing investment. Therefore, agricultural mechanization is considered to be an urgent task for the country. In recent years Rwanda has been the largest contributor of participants attending the FMTs. Presently, the adoption of agricultural mechanization is at only four percent; therefore, farming activities remain largely dependent on human and/or animal power.

One participant, working within the Ministry of Agriculture and Animal Resources (MINAGRI), modified an original prototype of "pedal thresher" developed by instructors during the FMTs. This modified prototype was demonstrated within their organization and given coverage in the local media. The resulting attention prompted the local JICA office, to fund a related nation-wide workshop facilitated by FMT instructors from Japan in cooperation with former FMT participants. The success of this workshop led a local private company, Metal Work Solution Ltd, to commercialize the prototype under the trade name 'the machine'. Subsequently, 'the machine' was selected as a recommended agriculture machine by the USAID-PHHS project, and 50 % of the funding necessary for mass production was subsidized by USAID. This resulted in 200 machines being leased freely to framers in rural areas. This is an example of a prototype developed by participants spreading out to farmers as the final beneficiaries. The prototype produced by one participant during his stay in Japan resulted in farmers receiving tangible benefits; drastically reducing the labor involved in the rice threshing process and freeing time for the cultivation of alternative crops. It has been reported that production volumes for other crops increased by 140 % during this period. 'the machines' are still sold in markets in Rwanda and have received some further development and modification. It generally takes 3 years to realize the impact of the FMT. In brief, FMT have provided a strong impact in Rwanda. See Figure 2 below.

Tree Style Type Transfer produced a strong impact towards agricultural mechanization in Rwanda and similar results have also been observed in Bangladesh, Tajikistan, and Bhutan. A correlating factor between these cases is the existence of an enthusiastic participant who initiates processes leading to the Tree Type Transfer exchanges. Motivation of individual participants appears to bear a close relationship with the success of Transfers in developing countries.

### 3.1.4 Complex Style Transfer (Type 4)

A Type 4, Complex Style Transfer is defined as knowledge acquired during the FMT by a participant who subsequently spreads beyond their country. This type of Transfer provides a great impact towards agricultural mechanization in both the participant's country and neighboring countries. It is this type of transfer, which has produced some of the most significant outcomes during the past 50 years of FMT. However, as it

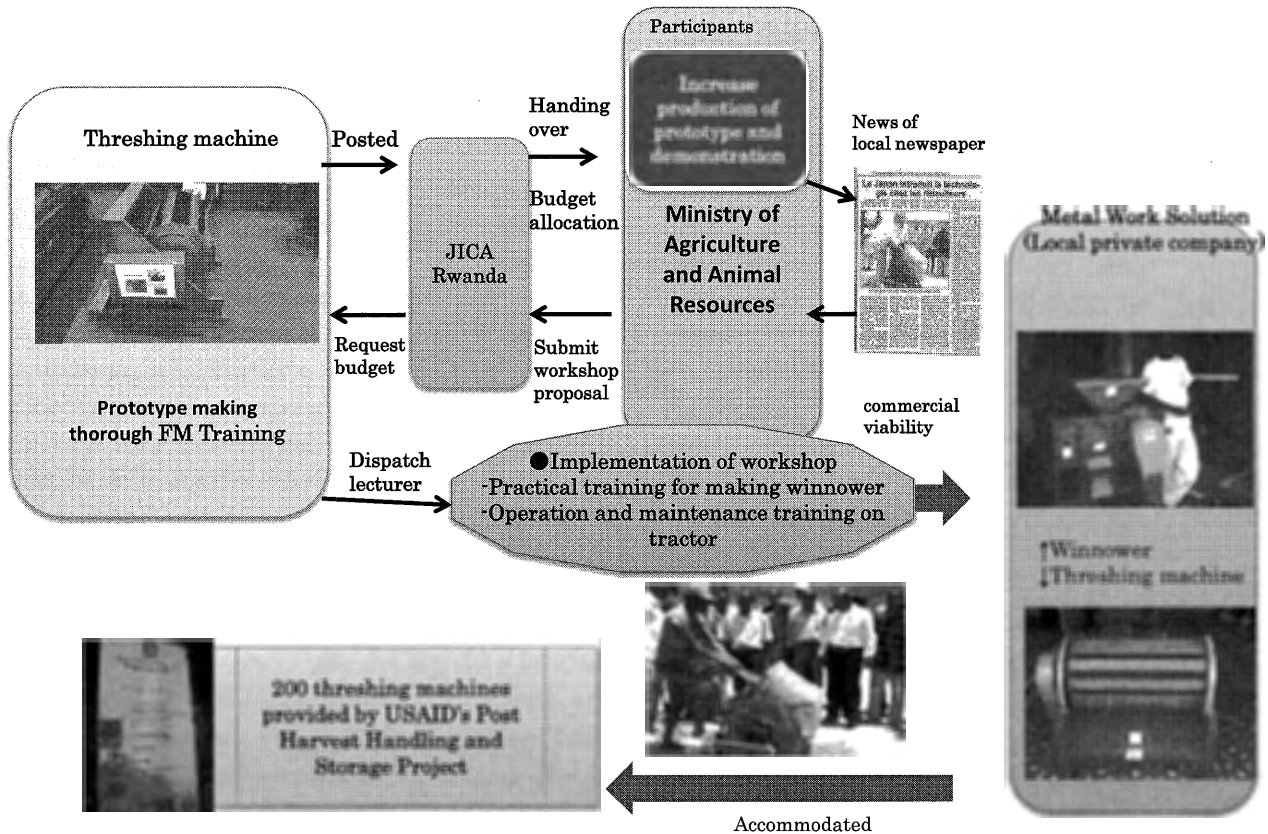


Fig. 2 Case study in Rwanda

involves various institutions and participants' organizations, such as, an institute to research the machine and a local private enterprise to take up mass production, it generally takes a long time, often more than 5 years to realize the impact of the FMT. Therefore, it is rare to witness a successful case with this type of transfer; nonetheless, it is still worthwhile focusing on this Transfer type as a potential progression onwards from Type 2 and Type 3 Transfers. Below is a case study from Thailand;

Thailand is a country at the center of the Indochina peninsula. Between 1985 to 1996, Thailand experienced one of the world's highest economic growth rates as it transformed into a newly industrialized country (a semi-developed country as categorized by the UNDP) that began to export industrial products rather than depending substantially on crop production. This transformation is widely considered to be partly the result of Thailand's policy to accept direct foreign investment and to invite manufacturing companies from Japan, USA, and the EU, to locate within the country. The following companies have local operations/production in Thailand: Kubota Co. Ltd. and Yammer Co. Ltd. established a local corporation in 1978; SATAKE Co. established an office in 1978, and Iseki Co. Ltd. opened a branch office in 2013.

The total number of participants from Thailand having completed FMT courses is 58, with most participants on the "Farm machinery design course" (1982-2000) belonging to

the Agricultural Engineering Research Institute (hereinafter referred to as AERI). The survey shows that 70 % of participants continued to develop their prototypes, produced during the FMT, as part of their day-to-day activities after returning to their countries. Examples of modified prototypes are: Pump, Sowers, Power tiller, Bush cutter, Rice husk furnace, Sprayer, Dryer, Rice huller, Fruit and vegetable dryer, Fruit grader etc. In particular, participants' modified prototypes for a Pump and Power tiller were test-manufactured with local private enterprises and blue prints produced. These prototype machines went on to be manufactured and full production undertaken by a local company. Machines were exported to several other countries in the Indochina peninsula, which resulted in a rapid expansion of Agricultural mechanization across a whole region. Annually, 200 000 to 300 000 Pump units are exported, and more than 800 000 Power tillers (a walking type tiller called the Iron Buffalo) were exported from Thailand to countries in the Indochina peninsula.

Complex Style Transfers can spread beyond national borders giving a great impact upon agricultural mechanization. A similar case has also been reported from the Agricultural Machinery Development Institute, Ministry of Agriculture, in Indonesia.

### 3.2 Mechanisms for the transfer (formulating FMK-net)

Through analyzing the case studies, considered above

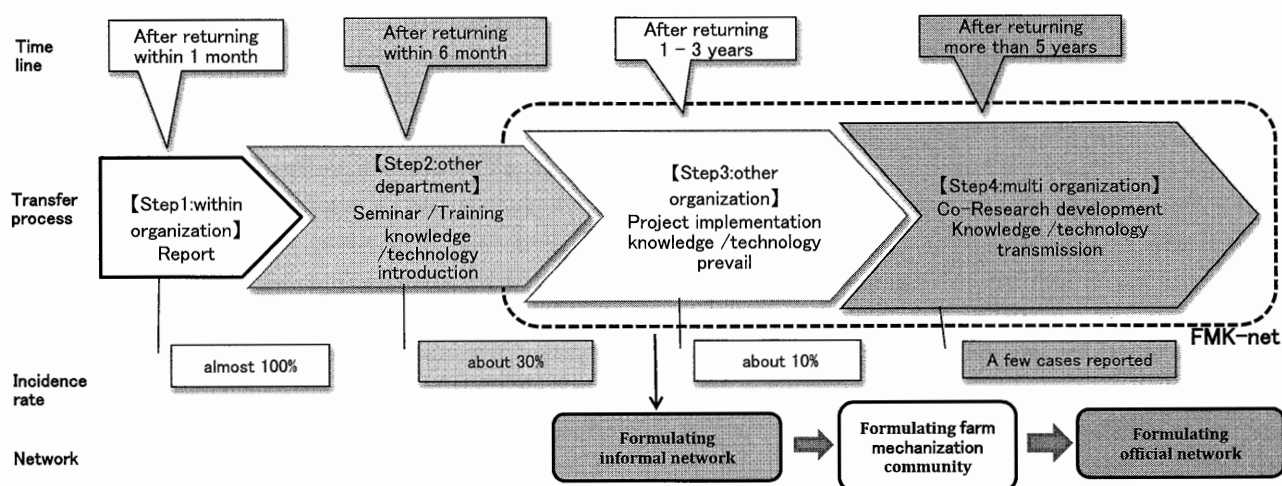


Fig. 3 Mechanism of transfer

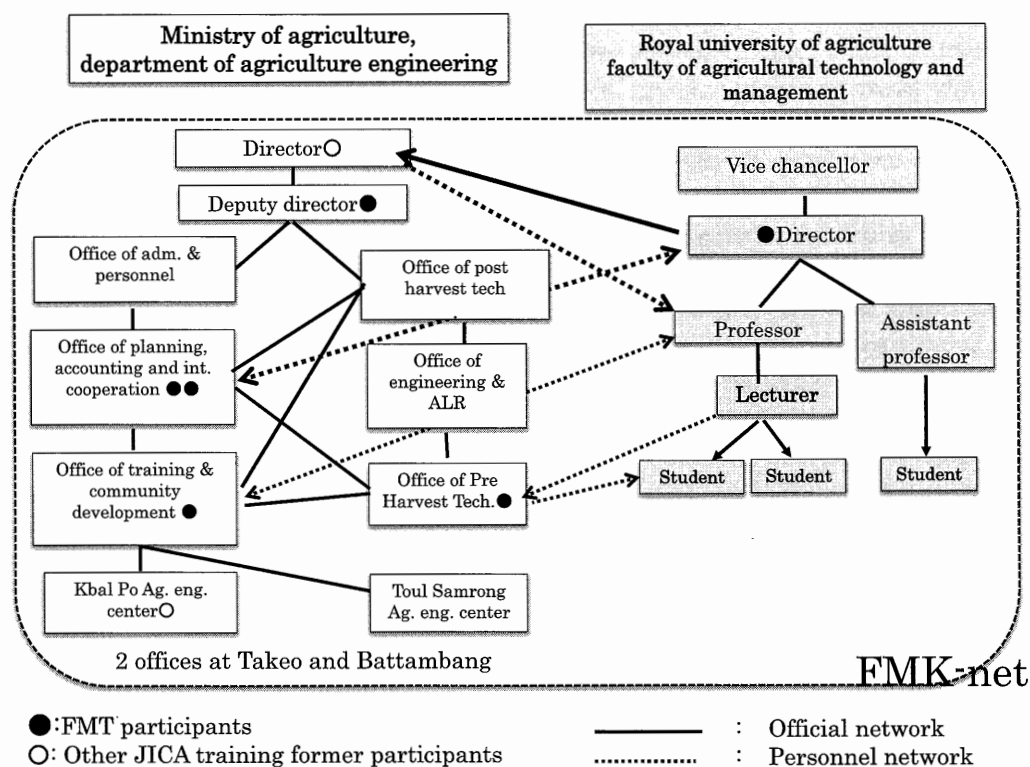


Fig. 4 Farm mechanization knowledge network (FMK-net) formulation in Cambodia

3.1, together with the timing and utilization of the transferred knowledge and technology after participants returned to their home countries, it is possible to expound similar mechanisms for knowledge and technology transfers throughout the world. It was noted that an informal knowledge network (hereinafter called "FMK-net"), had been created among the experts as a by-product of the training after third parties, such as private enterprises and other similar types of organization, became involved in Transfer process. See Figure 3.

Considering the case study of Cambodia, described above 3.1.2, it can be seen in Fig. 4 that an informal network has

already been established between the DAEng and RUA<sup>2</sup>. The head of Faculty from Agricultural technology and management (FATM), RUA has attended FMT course. His predecessor is the Director of the DAEng (Solid line). In this connection, there are 100 students attending the Agricultural Machinery course at FATM with graduate students from RUA being employed within DAEng every year and create informal network using personal relationship (Dotted line). Through an informal

<sup>2</sup> RUA is the sole agricultural university in Cambodia. RUA comprises five Faculties, Animal sciences, Agriculture engineering, Forestry and Fishery (2013)



network created by personal relationship between the two organizations Transfer activities have been facilitated. It was found during the field survey that it was this type of network that had grown to become the FMK-net in Cambodia.

At the level of Tree Style Transfer, the case of Rwanda described above in 3.1.3, illustrates a situation where the implementation of a national seminar and the USAID project assisted with the formation of an agricultural engineering community between not only, the direct participants of FMT but also involving other organizations and experts. With the further progression of agricultural engineering some of these networks will become formalized communities for agricultural engineering leading the promotion of farm mechanization in Rwanda in the near future.

The final stage of Complex Style Transfer can be observed in the case of Thailand, described above 3.1.4, where the Thailand Agricultural Machinery Institute was officially established and a National Agricultural Machinery Center (NAMC) was set up at Kasetsart University for the promotion of the agricultural mechanization process. The promotion of was undertaken through cooperation between industry, government and academia and these combined efforts were able to successfully boost local production of agricultural machinery in the country. With the progression of agricultural engineering in Thailand some of these networks have become formalized, such as those between academic societies and associations.

In this context it is possible to examine the practical and future uses of FMK-net as an early stage outcome of Transfer in relation to the contents of the FMT. In developing countries, human resources in the field of agricultural engineering are very limited, with each operative within the discipline being regarded as a potential expert. As a result, expansion of FMK-net is inevitably limited; however, participants who act as core contributors to the network can be very influential with strong links evident between the limited numbers of members. Significant features of FMT are: its comparatively long duration (it is a continuous 8 to 11 months), small group size, and the focus on practical training. These factors often lead to a positive “Teacher/pupil relationship” developing between participants and FMT instructors. Opportunities to, attend lectures given by machinery development staff, participate in field trips to factories, and to take part in prototype machinery evaluations, gives every participant a sound knowledge and trust in Japanese machinery.

### 3.3 Survey of overseas business activity by Japanese agricultural machinery/facilities manufacturers

Eight companies were visited and interviewed between 2012 and 2014 with the aim of discovering their motivations for cooperating with FMT and any problems/challenges that they believed they might face should they start overseas operations. The results of the interviews are shown in Table 1.

Results from the interviews showed that, in more than half of the companies surveyed, they had already started continuous overseas operations. For example, there had been consultation with former participants prior to opening a factory and some had sold their products to participants’ organizations. These reports indicate that, in practice, FMK-net can be a useful resource for private enterprises. In some cases, FMT initiated the creation of personal relationships between enterprises and participants, which later offered opportunities for business. However, each enterprise maintained that their cooperation with the FMT was to support Japan’s ODA or to contribute to the wider community as corporate social responsibility (CSR), and that they were not primarily aiming to use the FMT for the benefit of their businesses.

Some enterprises would not conclude sales contracts with institutes in developing countries solely through ex-participants, feeling that they needed to have someone they could trust more fully, such as, a JICA expert or an ex-participant in a senior position. Sometimes they simply lacked sufficient confidence in the judgment of ex-participants regarding the applicability of their products in developing countries. It might be considered as natural that enterprises are cautious, as failure of an overseas expansion could cause a SME to collapse.

It was concluded that providing enterprises with local information from counterparts or governmental organizations was crucial in helping to reduce their concerns.

It was found that the FMK-net based in Japan (JFMK-net), created between FMT instructors and enterprises more than 50 years ago, has been usefully supporting FMT. However, the JFMK-net is quite a closed and limited network; it has not been used to expand information about ODA to others outside the network, so that the SMEs in provincial cities have not been provided with sufficient opportunities to get in touch with the FMT.

### 3.4 Effectiveness of strengthening JFMK-net and participants with the aim of assisting SMEs to expand their overseas operations through FMT

Two enterprises, shown in table 2, took part in an exercise to verify the feasibility of developing overseas operations using JFMK-net. In this trial as shown in Fig. 5, the authors and a FMT instructor functioned as facilitators between the SMEs and participants using the measures for FMK-net strengthening. While supporting FMT, both enterprises considered commencing overseas operations through utilizing FMK-net in developing countries. As seen in the instance above, an existing informal network in developing countries (as shown in left figure) can be transformed into a formal network (as shown in right figure) that includes Japanese SMEs and which facilitates the transfer of new knowledge and technology. FMK-net was reported to be a highly relevant tool for them in this application.

One company that found particular value in using the

network to develop its overseas activities travelled to developing countries three times during 2013 and 2014 and succeeded, with local experimentation, to develop a machine for the overseas market in December 2014. The business commented that FMK-net could provide a valuable foothold for SMEs

when starting overseas business operations.

In the second case; in spite of the fact that the President of the company had an aspiration to start an overseas operation, the company had been unable commence international business, reportedly due to insufficient trade information available locally.

Table 1. Result of interviews with Japanese farm machinery/facility manufacturers

	Company A	Company B	Company C	Company D (SME)
Overseas business expansion	Yes	Yes	Yes	No
Overseas market expansion	Yes	Yes	Yes	Yes
Cooperation period of FMT*	appr 40 Years	appr 40 Years	appr 40 Years	appr 50 Years
Cooperation method of FMT	Factory tour (Domestic/Overseas)	Factory tour (Domestic) Dispatch of lecturer (Product operation training)	Factory tour (Domestic) Dispatch of lecturer (lecture, Product operation Training) Direct contract with JICA on FMT course	Factory tour (Domestic) Dispatch of lecturer (lecture, Product operation training)
Motivation for the cooperation of FMT (Positive or not?)	<ul style="list-style-type: none"> <li>Not positive, but if there is any request, do our best</li> <li>A part of CSR</li> <li>ODA (2KR and Dispatching expert to developing countries) is one of our overseas business target</li> </ul>	<ul style="list-style-type: none"> <li>Positive</li> <li>Responsibility of the Japanese company to cope with Japanese government</li> <li>Close relationship with JICA expert in the developing countries</li> </ul>	<ul style="list-style-type: none"> <li>Positive</li> <li>One of the Strategy of the overseas business expansion through participants in the past.</li> </ul>	<ul style="list-style-type: none"> <li>Positive</li> <li>Social responsibility, Local responsibility and Employee's satisfaction</li> </ul>
Inquire after FMT participants	Yes	Yes	Yes	Yes
A beginning of the selling product thorough FMT participants	No	No	Yes	Yes
Utilization of the FMT participants for overseas business expansion	No	No	Yes	No
Further cooperation for the FMT	Yes	Yes	Yes	Yes
Expansion of the overseas business thorough ODA Scheme	No	No	No	Yes

	Company E (SME)	Company F (SME)	Company G (SME)	Company H (SME)
Overseas business expansion	No	No	No	No
Overseas market expansion	Yes	Yes	No	Yes
Cooperation period of FMT*	appr 50 Years	under 10 Years	appr 30 Years	under 10 Years
Cooperation method of FMT	Factory tour (Domestic) Dispatch of lecturer (lecture)	Factory tour (Domestic)	Factory tour (Domestic) Dispatch of lecturer (Lecture)	Factory tour (Domestic) Dispatch of lecturer (Lecture)
Motivation for the cooperation of FMT (Positive or not?)	<ul style="list-style-type: none"> <li>Very Positive</li> <li>Meet with the corporate philosophy, and social responsibility</li> </ul>	<ul style="list-style-type: none"> <li>Positive</li> <li>One of the strategy of the overseas business expansion cooperate with FMT Courses</li> </ul>	<ul style="list-style-type: none"> <li>Positive</li> <li>Good opportunity for employee to meet with the overseas participants</li> </ul>	<ul style="list-style-type: none"> <li>No information about the developing countries business situation due to the located in the local town</li> <li>Acceptance of the overseas participants is the first step to expand overseas business</li> </ul>
Inquire after FMT participants	Yes	Yes	No	No
A beginning of the selling product thorough FMT participants	Yes	Yes	No	No
Utilization of the FMT participants for overseas business expansion	No	No	No	Yes
Further cooperation for the FMT	Yes	Yes	Yes	Yes
Expansion of the overseas business thorough ODA Scheme	Yes	Yes	No	Under consideration

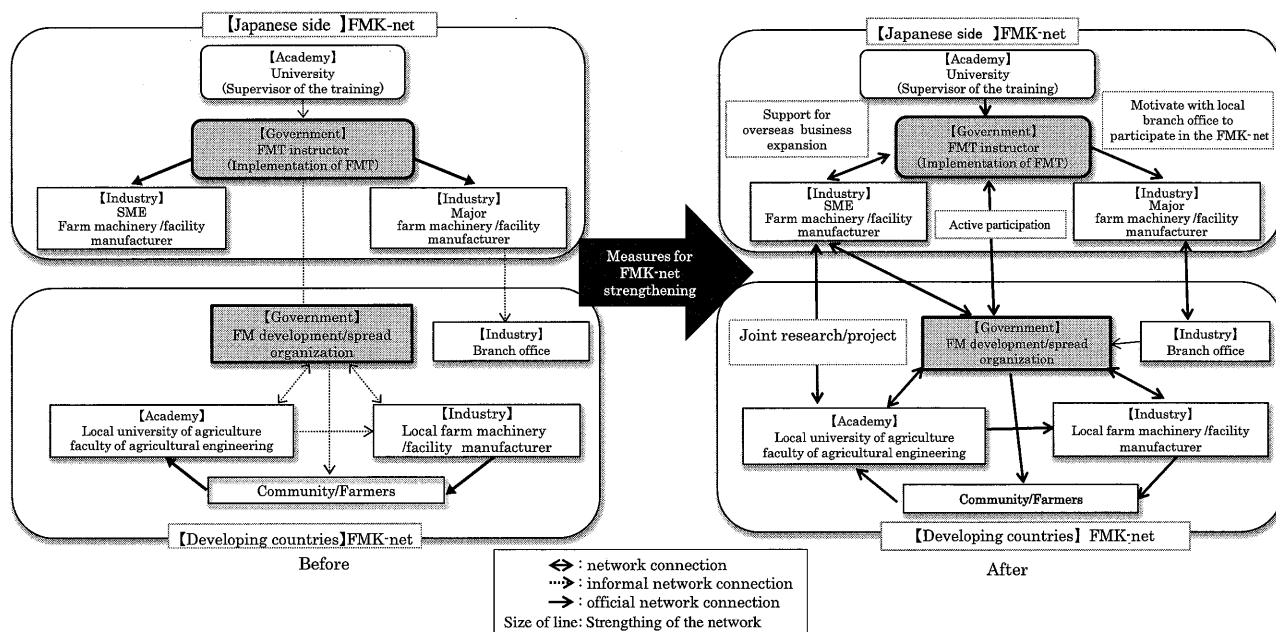


Fig. 5 Before /After comparative figures for FMK-network strengthening activities

While the company was investigating opportunities, one of the company's personnel met some of the FMT instructors whilst visiting agricultural machinery fair with FMT participants. During their discussion he spoke with the FMT participants and quickly saw a potential avenue for marketing his machines overseas through constructing a network with the participants. After consultations with the FMT instructor regarding the possible adaption of his company's machine for long grain rice (IRII developed rice), he expressed a wish to expand his business overseas utilizing the participants' network. This resulted in 500 kg of long grain rice, cultivated by the participants, being provided to the enterprise for experimental development work and led to the enterprise deciding to support the FMT as an initial step towards overseas operations. A first field visit to the company's factory took place in May 2015 and use of FMK-net by participants and the enterprise continues to develop through on-going technology transfers.

From these cases, it is possible to verify that the FMT and FMK-net offer effective paths for SMEs to launch overseas operations; with FMK-net providing an indispensable aid in the adaption and marketing of agricultural machinery. Unlike other industrial products, such as, consumer electrical appliances, Japanese agricultural machinery cannot be directly accepted for use in developing countries without first undertaking testing and modification in accordance with crop types, soils, and local weather conditions. Therefore, SMEs have to examine and improve their machines prior to applying for local use and undertaking market surveying to ascertain appropriate pricing levels.

Presently, Japan is in an era where agricultural machinery manufacturers face intense and increasing competition

from countries such as China. To survive in this competitive business environment, Japanese SMEs should seek to utilize FMT and FMK-net to develop growing overseas markets rather than hope for a breakthrough technology relevant within Japan's shrinking agricultural machinery market. As has been explained, the merits of using FMT and FMK-net are:

- Creation of a network with participants; Enterprises are able to explain and promote their products to participants who are key persons of influence for their professional fields in their home countries. Knowing the opinions of such local technicians should prove highly advantageous to companies attempting to amend their machines for export to developing nations.
- Long grain rice is cultivated by the participants as part of their training. Interested Enterprises can use this local supply of long grain rice to test their products for adaption for overseas use.
- FMT instructors are available to accompany Enterprises while undertaking surveys and negotiations overseas. They can provide technical advice, interpretation services, and introduce local contacts through FMK-net.

These three advantages make it is possible to mitigate concerns regarding possible risk factors; as pointed out by more than half of the Enterprises interviewed. These factors are;

- Difficulty in finding the necessary materials to test potential overseas products
- Problems with identifying trustworthy local counterparts
- Difficulty with obtaining sufficiently detailed information regarding established business practices and market trends in the prospective counties

#### 4. Conclusions

FMT courses have not only played a role in human

resource development for agricultural engineering but have also performed a significant function in the popularization of agricultural mechanization in developing countries. In this study, aimed at improving future training courses, it has been possible to verify the impact of agricultural mechanization in developing countries through questionnaire and field surveys, which consider the implementation of knowledge and technology transfers, acquired during FMT courses, and applied by participants after returning to their home countries. The following conclusions were drawn;

- 1) It was confirmed that the participants transferred their knowledge and technology, learnt through the FMT courses in Japan, on return to their home countries using the four types of Transfer method. This transfer has similar mechanisms, which was the development of FMK-net between participants and experts in agricultural machinery.
- 2) FMK-net, created as a by-product of knowledge and technology transfer activities, has proved beneficial for Japanese SMEs when they have wished to commence overseas operations in developing countries. This is especially the case as presently the information available to SMEs is quite limited with insufficient opportunities to invest in marketing activities.
- 3) In the future, the objective of FMT could not be limited simply to the capacity development of participants from developing countries, but could also target the creation of opportunities for Japanese SMEs to start overseas operations. To accomplish this goal, the training course is subject to provide multiple opportunities for participants and SMEs to come together and communicate. Therefore, FMK-net both in Japan and in developing countries could be expanded and links strengthened. Researchers and officials from government, public institutes, university academics, and representatives from private enterprise might be encouraged to attend the Annual Meeting of the Japanese Society of Agricultural Engineering. If participants taking part in the FMT could also attend the meeting and present the current situation regarding agricultural machinery/facilities in their countries, together with their prototypes produced during the training course, this could further enhance mutual understanding between Japan and developing countries.

4) With one objective of FMT being the creation of a positive environment for Japanese SMEs to launch overseas business operations, more participants could be chosen from countries such as, Thailand, Cambodia, Myanmar, and Indonesia. In these South East Asian countries, FMK-net has already become established and it would be more straightforward for Japanese SMEs to launch businesses there compared with comparatively far distant countries. While FMT has an abundance of experience, it can nonetheless continue to evolve new types of knowledge and technology transfer methods relevant to present day needs. Japanese Enterprises might engage with training courses where they have the potential to play an important role in technology transfer; while FMK-net in developing countries can assist the SMEs to launch their businesses overseas.

5) These proposals could ensure that FMT can be a prototype for Japanese ODA while continuing to develop new methodology for knowledge and technology transfers in the field of agricultural mechanization for developing countries.

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## 開発途上国の農業機械化促進に有効な 技術・知識移転に関する調査研究<sup>\*1</sup>

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### 要 旨

JICA（国際協力機構）筑波国際センターでは、1964 年から開発途上国の国を代表する行政官や農業技術者対象に農業機械研修を通じた技術協力の一つである人材育成事業を継続的に実施してきた。

将来の農業機械研修の一層の発展に資する事を目的に、同事業が途上国の農業機械化に対してどのようなインパクトを与えてきたかを検証するため、同事業による研修員の帰国後の活動調査を実施した。複数年にわたる調査の結果、研修員は帰国後、農業機械研修で得た知識・技術の移転活動を行っていることが確認された。この技術移転の波及効果は経過時間・波及度合いにより 4 つのパターンに類型化され、一定の発現メカニズムを有することがわかった。また、この技術移転活動の過程において農業機械専門家間で知のネットワーク（FMK-net: Farm mechanization knowledge network）が形成されていることが明らかとなった。

さらに、農業機械研修に協力を得ている中小の農業機械・施設メーカーへの聞き取り調査を行ない、農業機械研修を利活用した海外進出を試みた。結果、農業機械研修を通じた企業と FMK-net 連携が、将来的な海外ビジネスを模索する中小メーカーの海外進出に際して有効である事の一端が明らかとなった。また、途上国への新たな技術移転方策としても有用であることが判明した。

キーワード：農業機械研修，知識・技術移転，農業機械研修員間の知的ネットワーク（FMK-net），海外進出ビジネス